Notice to Reader.—When you finish reading this magazine, place a 1 cent stamp on this notice, mail the magazine, and it will be placed in the hands of our soldiers or sailors destined to proceed overseas. No wrapping—No Address. *A. S. Burleson, Postmaster-General.*

SCIENCE

NEW SERIES
VOL. XLVIII No. 1250

FRIDAY, DECEMBER 13, 1918

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $5.00

A New Blakiston Book

Webster's Paper-Work of the Medical Department, U. S. Army

By RALPH W. WEBSTER, M.D., Ph.D.

Major Medical Corps, U. S. Army; Instructor, Basic Military Course, and Adjutant, Camp Greenleaf, Chickamauga Park, Georgia; Formerly Instructor at the Medical Officers' Training Camp, Fort Riley, Kansas; Author of "Diagnostic Methods, Chemical, Bacteriological and Microscopical."

Approved for Publication by Direction of the Surgeon General, U. S. Army

8vo. 570 Pages. Cloth, $5.00 Prepaid

A reference book that should be found on the shelves of every library and in medical colleges. It gives a full description of the blanks, reports, instructions, etc., and numerous fac-similes of properly filled-in forms for use as a guide. Its use will insure prompt and correct execution of all the prescribed reports and returns.

P. BLAKISTON'S SON & CO.

PUBLISHERS PHILADELPHIA

Publications of
Carnegie Institution of Washington

The publications of the Institution now number over 350 volumes, the subjects including Anatomy, Archæology, Astronomy, Botany, Chemistry, Economics and Sociology, Embryology, Experimental Evolution and Heredity, Engineering, Folk-Lore, Geology, History, International Law, Literature, Mathematics, Medicine, Nutrition, Philology, Physics, Zoology. Classified and descriptive lists will be sent postpaid on application.

No. 78. SHAW, J. B. Synopsis of Linear Associative Algebra: A Report on its Natural Development and the Results Reached up to the Present Time. Quarto, 145 pages. Price, $1.50.

No. 120. DECKER, F. F. The Symmetric Function Tables of the Fifteenthic. Quarto, 21 pages. Price, $1.25.

No. 105. LEHMER, D. N. Factor Table for the First Ten Millions, containing the smallest factor of every number not divisible by 2, 3, 5, or 7 between the limits 0 and 10017000. Folio, xiv+476 pages. Bound in Leather and Buckram. $20.00; Unbound, $18.00.

No. 165. LEHMER, D. N. List of Prime Numbers from 1 to 10006721. Folio. xvi+133 pages. Price, $5.00.

RECENTLY ISSUED

No. 245. HEDRICK, H. B. Interpolation Tables or Tables of Proportional Parts, containing the Products of the nearest unit of all numbers from 1 to 100 by each hundredth from 0.01 to 0.99 and of all numbers from 1 to 1000 by each thousandth from 0.001 to 0.999. Folio. 149 pages. Price, $5.00.

IN PRESS

No. 256. DICKSON, L. E. History of the Theory of Numbers. Octavo. Vol. I. Divisibility and Primality. In press.

All communications should be addressed to

CARNEGIE INSTITUTION OF WASHINGTON
WASHINGTON, D. C.

In treatment synthetic rather than algebraic

Lehmer's Elementary Course in Synthetic Projective Geometry

gives the student a wide outlook, a familiarity with many theorems useful in later work, and a certain power of visualization valuable in analytical studies. "Synthetic Projective Geometry" is peculiarly fitted for short courses. It can be given to the average freshman class in three hours a week through one semester. It may, however, be easily adjusted to longer courses, if desired. The course includes correspondences, point rows and pencils of the first and second order, Pascal's and Brianchon's theorems, duality, poles and polars, involution, metrical development, and a chapter on the history of the subject.

xiii+123 pages. $1.12

Ginn and Company

Boston · New York · Chicago · London · Atlanta · Dallas · Columbus · San Francisco

The University of California Press

Berkeley, California **280 Madison Avenue, New York**

SOME TESTS OF DOUGLAS FIR AFTER LONG USE

By Arthur C. Alvarez..... .70

The Strength of Long-Seasoned Douglas Fir and Redwood, by Arthur C. Alvarez..... .10

Some Compression Tests of Portland Cement Mortars and Concrete Containing Various Percentage of Silt, by Arthur C. Alvarez and James R. Shields ..... .25

The Wintun Hesi Ceremony, by S. A. Barrett..... .50

New Pacific Coast Marine Algae III, by Nathaniel Lyon Gardner..... .35

New Pacific Coast Marine Algae IV, by Nathaniel Lyon Gardner..... .10

The above titles represent *University of California Publications* in Engineering, Anthropology and Botany. Other series published by the University of California include Agricultural Sciences, Entomology, Geography, Geology, Pathology, Physiology, Psychology, and Zoology.

Complete lists of titles and prices will be sent on request

GAS—GAS

The "Detroit" Combination Gas Machine

Automatically makes the best and cheapest gas for

Laboratory Uses of Every Character

Heating—Cooking—Lighting

Over 30,000 in daily use

Descriptive catalogue and names of users in your locality sent on request

THE DETROIT HEATING & LIGHTING CO.

612 Wight St. **Detroit, Mich.**

Established 1868

SCIENCE

FRIDAY, DECEMBER 13, 1918

CONTENTS

Problems, Methods and Results in Behavior: PROFESSOR S. O. MAST 579

George Jennings Hinde: MARJORIE O'CONNELL 588

Inquiry of the American Geographical Society for the Information of the Peace Commissioners 590

Scientific Events:—

The Salters' Institute of Industrial Chemistry; The Influenza Epidemic; The Return of Chemists to the Industries; The American Psychological Association; The Yellow Fever Expedition of the Rockefeller Foundation 592

Scientific Notes and News 596

University and Educational News 598

Discussion and Correspondence:—

A League of Nations: PROFESSOR W. M. DAVIS. *Experimental Osmosis with a Living Membrane:* PROFESSOR EDWARD KREMERS. 598

Quotations:—

France's Share in Biology and Medical Science 600

Scientific Books:—

Adami on Medical Contributions to the Study of Evolution: J. P. McM. 601

Special Articles:—

Stylonichia impaled upon a Fungal Filament: D. H. WENRICH 602

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

PROBLEMS, METHODS AND RESULTS IN BEHAVIOR[1]

INTRODUCTION

IN every field of endeavor it is from time to time advantageous to pause long enough in the ordinary pursuits of the day to take our bearing, trace the course traveled and adjust plans for the future. I have attempted to do this in the field of behavior and I shall present in brief the result of this attempt.

What I have to offer is in no sense a finished product. It should be looked upon rather as the opening of a discussion, a brief exposition of certain ideas which I hope will be criticized from various points of view.

HISTORICAL REVIEW

Before the renaissance no practical problems in behavior were recognized. All activities in organisms, plants as well as animals, were held to be under the control of souls, agents not amenable to law and not subject to experimental analysis.

Descartes early in the seventeenth century came to the conclusion, partly from the results obtained in observations, partly on the basis of philosophic speculation, "that the bodies of animals and men act wholly like machines and move in accordance with purely mechanical laws." Under the inspiration of this idea, Borelli and others undertook to reduce certain reactions to purely physical and chemical or mechanical principles. Somewhat later Ray, Dodart, Du Hamel and others attempted to account for the movements in plants on the same basis. Thus the science of behavior had its origin, and, strange as it may seem, the fundamental problem before it in its youngest days was to reduce reactions to mechanical principles.

The investigators interested in this en-

[1] An address delivered at the Marine Biological Laboratory, Woods Hole, Mass., July 15, 1918.

deavor were enthusiastic and numerous; so-called mechanical explanations were offered for all sorts of reactions, but these explanations were so extremely simple and crude that they soon came to be looked upon as worthless and the mechanistic concept of behavior fell into disrepute resulting in a period of stagnation.

Not until early in the nineteenth century was interest in the reactions of organism revived. During this period numerous observations and experiments were made on plants, all form a purely mechanistic point of view and very encouraging results were obtained. The work on the behavior of animals consisted, however, almost entirely in superficial observations and the collection of anecdotes, mainly concerning reputed marvelous feats performed. The dog and the fox were favorite subjects, but all sorts of animals were dealt with. We have as a result of this work numerous volumes testifying to the interest in the subject. Menault's "Wonders of Animal Instinct," running through five editions, Jesse's "Anecdotes of Dogs," Swainson's "Habits and Instincts," Cough's "Instincts," etc. These anecdotes are all essentially the same in character. Let me illustrate by quoting one from Menault.

> "The following has been related by one of our most eminent naturalists, who heard it from a person worthy of credit:
>
> A young lady was sitting in a room adjoining a poultryyard, where chickens, ducks and geese were disporting themselves. A drake came in, approached the lady, seized the bottom of her dress with his beak, and pulled it vigorously. Feeling startled, she repulsed him with her hand. The bird still persisted. Somewhat astonished, she paid some attention to this unaccountable pantomine, and discovered that the drake wished to drag her out of doors. She got up, he waddled out quickly before her. More and more surprised, she followed him, and he conducted her to the side of a pond where she perceived a duck with its head caught in the opening of the sluice. She hastened to release the poor creature and restored it to the drake, who, by loud quackings and beating of his wings, testified his joy at the deliverance of his companion."

It was generally assumed during this period that animals are endowed with mental faculties similar to those in man and the main incentive in all of this work was the inculcation of humane treatment of animals. The distribution and extent of pleasure and pain in the animal kingdom was the problem of the day. Menault says in his preface: "The marvels of animal intelligence claim now, more than ever, the attention of observers." "We believe that the lower animals possess, in a certain degree, the faculties of man," and Jesse says: "The better the character of the dog is known, the better his treatment is likely to be, and the stronger the sympathy exerted in his behalf."

The "Origin of Species," which as you know appeared in 1859, opened a new field in behavior. Evolution came to dominate every phase of biology, and the evolution of reactions and psychic phenomena came to be the central problem in animal behavior. To the solution of this problem a number of able investigators devoted their energies (Darwin, Lubbock, Bert, Romanes, Preyer, Graber, et al.).

All of these men concluded on the basis of the results obtained that psychic phenomena extend well down in the animal kingdom and some of them even contended that there are indications of such phenomena in plants. Thus they maintained that all organisms are functionally and psychologically interrelated in the same way as they are structurally, and that the mental faculties of man originated in primitive forms.

Whatever view one may take regarding these conclusions, the fact remains that the experimental work of some of the investigators mentioned is of the highest order and the results obtained have been largely confirmed. I should like to refer particularly to Lubbock's ingenious and thorough work on light-reactions in *Daphnia* and color-vision in bees. Critics should always bear in mind that these investigators were interested in the origin and evolution of responses and of psychic phenomena, and not in the mechanics of reactions.

During the latter part of the nineteenth

century students of animal behavior again returned to the problem which dominated behaviorists of the early years of the seventeenth century, namely, the reduction of reactions to mechanical principles. Prominent among these students were Engelmann, Verworn, Loeb and Jennings.

The work of the last three investigators mentioned is in a general way very well known. That of Engelmann, however, seems to have been to a considerable extent overlooked, although it is among the very best that has ever been done in behavior. I should like to refer particularly to his investigations on *Euglena*, published in Pflüger's *Archiv* in 1882, several years before any of the others mentioned began work in this line.

Engelmann finally concluded, after years of searching observations on the relation between physico-chemical phenomena and the reactions in various unicellular forms, that while many of the reactions in these forms are purely mechanical some of them can not be explained without postulating psychic processes. This conclusion may be responsible for the fact that his work has not received the attention that it deserves.

Thus we see that one problem after another has dominated the work in behavior. Reduction of reactions to mechanical principles; distribution of pain and pleasure; the evolution of reactions and psychic phenomena; and again the reduction of reactions to mechanical principles. What has become of these problems? What are the fundamental problems in behavior to-day?

DISTRIBUTION OF PLEASURE AND PAIN

It has often been said that it is impossible to ascertain whether or not animals experience pleasure and pain and that it is consequently useless to attempt to ascertain the distribution of such phenomena in the animal kingdom. In a sense this is true but in this sense it is also true in reference to human beings. Subjective states can be ascertained with certainty by the investigator only as they exist in himself. He can not be certain that your pain is like his pain. All that he can do is to note his actions, including language, during the process of subjective experience, compare these actions with those in other individuals and base his conclusions upon the relation between them.

Precisely the same method is open to him in regard to other organisms, although it is evident that comparison of actions becomes more and more difficult as the difference between the structure of the organisms involved increases. The problem as to the nature and extent of pain and pleasure (feeling or sensation) consequently becomes more and more difficult as one descends in the organic realm.

This problem can, however, not be avoided. The behavior of every individual depends to a large extent upon his conclusion regarding the nature and extent of feelings in the creatures with which he comes in contact. Human society demands a decision of some sort or another regarding the distribution of these phenomena. Witness the work of the anti-vivisection organizations, societies for the prevention of cruelty to animals and charitable institutions everywhere, all built upon and acting upon decisions regarding this matter. The problem then resolves itself into this. Shall we permit human conduct in reference to such an important matter to rest upon judgments based upon evidence casually gained or shall we demand that it rest upon judgments based upon the results obtained in a comprehensive comparative study of the reactions of organisms under experimentally controlled conditions?

Many anti-vivisectionists and members of other anti-organizations who shed copious tears over cats and dogs in our laboratories do not hesitate to sit all day and impale earthworms, crabs and minnows on hooks, and they do not object to the practise in certain tropical regions of turning turtles and cutting steaks from them for a week or more while alive. They assume, of course, that earthworms, crabs, fishes and turtles do not suffer. Are they correct in this assumption or was Brooks correct when, after a lifetime of intimate association with animate beings of all sorts he said: "I try to treat all living things,

plants as well animals, as if they may have some small part of a sensitive life like my own"? Or are those correct who maintain that sensations in all organisms below the upper stratum of human beings are insignificant?

This question can not, at present, be definitely answered and it may never be definitely answered but a comprehensive comparative study of the reactions of organisms bearing directly upon it will unquestionably make it possible to answer it more nearly correctly than can be done to-day.

The field in this line is open. Practically nothing of a thorough going nature has been done in it. Among the best of the works on the lower organisms is that of Norman presented some twenty years ago. Norman showed that the squirming reactions in earthworms to violent stimulation do not constitute conclusive evidence of pain, for the simple reason that when a worm is cut in two the posterior part squirms violently while the anterior part with the brain does not. Reactions in other organisms led him to conclude that there is no satisfactory evidence of pain in any of the invertebrates. But even this work, which, as stated, is among the best, is far from comprehensive and the conclusions are consequently only meagerly supported.

ORIGIN AND EVOLUTION OF REACTIONS AND PSYCHIC PHENOMENA

It has become the fashion among certain ultra-modern psychologists to solve the problem of consciousness by contending that it does not exist. This contention is no doubt largely verbal. The term consciousness is not very specifically defined. It is used loosely by many, and the controversy as to the existence of consciousness is rooted in this fact. What is denied by some is, as I understand it, the existence of an entity capable of action and experience independent of matter. Regarding this I have nothing to say.

Practically every one who is sane, even the modern psychologist, admits that he is aware; he admits that phenomena may have a subjective as well as an objective reference or existence. Whatever else the term consciousness may imply it always implies awareness (subjective experience). As to the actuality of this phenomenon, we are, I believe, more certain than we are about anything else. The origin, the evolution and the nature of awareness, the processes associated with it and its relations to objective reality constitute, in my opinion, the most fundamental problems that confront the human mind, and all available methods of attack should be brought to bear upon them.

The introspection method has been extensively used in the investigation of some of the problems mentioned. This method is, at present, in disrepute and many have abandoned it altogether in favor of the so-called behavior-method. I do not believe that the tendency to entirely abandon introspection is wholesome, although it is of but little importance in reference to the question before us, the origin and evolution of reactions and consciousness, awareness or subjective phenomena. In the investigation of these questions two methods are promising. One might be called the comparative behavior method, the other the method of genetics.

The method of comparative behavior has been and is still being extensively employed. It consists in the comparison under given conditions of reactions in various organisms including man. It is anthropomorphic in its tendencies and owing to this it has been severely criticized both justly and unjustly. This is doubtless due largely, if not entirely, to misapprehensions as to the import of the method.

The method of comparative behavior was used almost exclusively by Lubbock, Graber, Romanes, Darwin and others interested primarily in the evolution of psychic phenomena. These investigators tried to ascertain whether or not this or that animal sees, hears, smells, tastes and feels.

The results obtained led them, as previously stated, to conclude that various animals, besides man, have subjective sensation. And since it was generally assumed that human behavior is, at least to some extent, controlled by subjective states, it was thought that the be-

havior of other animals is also thus controlled. This resulted in the anthropomorphic explanations of reactions current at the time. For example, it was maintained that organisms which are photo-positive go toward the light because they hate darkness or love light, that the moth flies toward the candle-flame to satisfy its curiosity, etc. These explanations have justly been severely criticized, and yet the method is not necessarily at fault.

If human conduct is dependent upon subjective states, and if other animals have such states, is it not altogether probable that their reactions are also dependent upon subjective states? If this is true it is possible to explain in a certain sense reactions in animals on the basis of psychic phenomena. It is maintained, however, that this is putting the cart before the horse, that it consists in attempting to explain the unknown in terms of something still more unknown. With this contention I do not agree, for I hold that every individual knows his subjective sensations better than anything else. The question, then, resolves itself primarily into this. Does conduct depend upon subjective sensations? If it does then it is evident that in the study of behavior it is of the greatest importance to ascertain the distribution of such sensations. But whether conduct is dependent upon subjective phenomena or not, knowledge regarding the distribution of such phenomena is fundamental; for it seems to be the only knowledge that bears upon the problems of the origin and evolution of consciousness.

We judge as to the presence and nature of such phenomena in others almost wholly by comparing their behavior with ours. We know that conscious states in ourselves are accompanied by certain reactions and when we see these reactions in others we conclude that their subjective experience is the same as ours, and by comparing the conclusions thus reached regarding subjective experience throughout the animate kingdom, we formulate conclusions as to the origin and evolution of these phenomena. I realize full well that conclusions based upon such evidence are precarious, but this method is the only method available in the investigations of subjective states in others, and precarious as the conclusions may be they are far more likely to be correct than those formulated without such investigations. We must consequently either abandon this profound problem altogether or proceed along the line indicated.

Aside from its bearing on consciousness the method of comparative behavior has an important bearing on the problems concerning the evolution of reactions themselves and their interrelation, their sequence. In its bearing on this problem comparative behavior is similar to comparative morphology. As comparative morphology yields results concerning the relation between structures in different organisms, so comparative behavior yields results concerning the relation between reactions. It is not primarily concerned in the relation between the environment and the reactions. Its primary interest lies in the relation between the reactions themselves as manifested in various organisms.

In regard to the evolution of reactions, the comparative method in behavior must, however, give way to genetics just as the comparative method in morphology has. In this field we have as yet scarcely made a beginning. It is a virgin field of great promise. I should like to refer to Yerkes's work on mice and McEwen's on Drosophila.

I have pointed out a number of important problems which are dependent for their solution upon the *relations between reactions* and not primarily, if at all, upon the *nature or the mechanics* of the reactions. There are many other problems which can be greatly illuminated by a study of such relations. I shall refer to but one of these, modifiability in behavior including habit formation and learning in general.

Much of the recent work on the behavior of the higher animals centers about this problem, the work of Thorndike, Morgan, Yerkes, Watson, Carr and others. The results of this work have been of inestimable value, practical as well as theoretical, and yet it is based almost entirely upon the relation between reactions. Practically nothing is known regard-

ing the mechanics of the reactions involved, and owing to their extreme complexity little is likely to be known for years to come. I should like to emphasize this point, for there are those who appear to hold that a study in behavior which does not deal with the reduction of reactions to physico-chemical principles has no practical value.

The study of modifiability in behavior should be much extended, especially in the investigation of the lower forms where it has as yet received but little attention, and closely associated with this is the problem of regulation, so clearly set forth by Jennings in the closing chapters of his book on the behavior of lower organisms.

Comparative behavior then, in spite of its anthropomorphic tendencies is valuable in certain lines of investigation, and I hope that what I have said may counteract the strong opposition that has developed against it. However, no matter what may be the immediate object of behaviorists, practically all of them desire to see reactions reduced, as far as possible, to mechanical principles. What has been accomplished in regard to this, and what are the prospects in reference to it?

THE MECHANICS OF REACTIONS

One of the foremost physiologists says in substance: Many reactions have already been reduced to physical and chemical or mechanical principles and all reactions together with all life-phenomena can be thus reduced. Another equally prominent physiologist says: "The attempt to analyze living organisms into physical and chemical mechanisms is probably the most colossal failure in the whole history of science."

How is it that the results obtained by two eminent and practical investigators in the same general field have led them to conclusions so diametrically opposed, the one maintaining that many vital phenomena have been and that all vital phenomena can be reduced to mechanics, the other apparently maintaining that no vital phenomena have been and that no vital phenomena can be thus reduced? The difference in these conclusions is in part, if not entirely, due to different conceptions as to what a reduction to mechanics involves.

Fundamentally all scientific knowledge is the same. It concerns the order of phenomena not the cause of the order. It is rooted in experience and founded upon the conviction that Nature is orderly, that a phenomenon that occurs under a given set of conditions will occur again whenever this set of conditions obtains. All of the scientific laws that have been formulated are merely expressions summarizing the results of experience, and their validity depends upon the extent of the experience. They are in no sense absolute; any and all of them may have to be modified as more experience is gained. To ascertain and to regulate the order of phenomena in nature is the purpose of science.

Mechanics deals with the relation between events or phenomena and changes in the configuration of material systems associated with such events. The reduction of behavior to mechanical principles consists in ascertaining the relation between reactions in animated systems and changes in material configurations within and outside of such systems. In other words, it consists in ascertaining the sequence in series of changes in material configurations ending in reactions. For example, suppose we have an alkaline medium containing paramecia and add a bit of acid, thus inducing avoiding reactions. The substance or material in the alkaline medium has a certain arrangement or configuration. When the acid is added this configuration is changed and this sets up changes in the material configuration within the paramecia which result in a response. That is, we have a series of changes in material configuration ending in a reaction, and similar series of changes precede all reactions.

Now, when the mechanist says that reactions have been reduced to mechanical principles, he probably means merely that some of the changes in material configuration in the series ending in reactions have been ascertained. And when the anti-mechanist says that the attempt to reduce reactions to mechanical principles has been a colossal failure,

he probably means merely that in no such series have all of the changes in material configuration been ascertained. If this is true then both views are doubtless corect; for it can not be disputed that some of the changes in material configuration in series ending in reactions have been discovered in numerous instances, and it can not be demonstrated that all such changes have been discovered in any instance.

Take for example, one of the very simplest, if not the simplest of all responses, changes in ameboid movement. It has been maintained that this reaction is due to changes in surface tension. Similar movements can be induced in inanimate systems. If a bit of potassium bichromate is brought near a drop of mercury in ten per cent. nitric acid the mercury will flow toward the bichromate. This is due to a local reduction in surface tension. This and numerous similar experiments, it is maintained, show that movements in Ameba are due to changes in surface tension. It has, however, recently been demonstrated that changes in surface tension can not produce the force required in certain ameboid reactions. Other factors have consequently been postulated to supply this deficiency. Now this is a perfectly legitimate procedure in scientific investigation. All that I wish to emphasize here is the fact that ameboid movement has not yet been completely reduced to mechanics. Even if it were conclusively demonstrated that every movement and every change in movement in Ameba is directly the result of changes in surface tension, it could still be maintained that the series of changes in material configurations associated with these phenomena is not completely known for such a demonstration would have no bearing upon the problem of the regulation of the movements.

Ameba can move in a homogeneous environment. Consequently, if its movements in such an environment are due to changes in surface tension, such changes are the result of *internal factors* concerning which practically nothing is as yet known. These factors may be purely physical and chemical, but it certainly can not be maintained that it has been demonstrated that they are. For all that is known to the contrary there may be non-material factors, entelechies and psychoids, involved in this regulation. Do not misunderstand me, I do not maintain that there are such factors involved, I merely hold that it has not been demonstrated that such factors are not involved.

In reference to regulation which constitutes the very essence of vital phenomena, we have indeed as yet traveled but a short way on the road toward reduction to mechanical principles, and it is mainly in this region that the anti-mechanist operates.

If we are correct in our analysis thus far, the essential difference between the mechanist and the antimechanist or vitalist is found in the fact that the former maintains that all reactions are completely determined by material configurations, and that all of the changes in such configurations can be ascertained, while the latter maintains that the reactions are not thus completely determined and that the changes in material configurations ending in reactions can be ascertained only in part. Which of these views is correct will be known, if it is ever known, only after every possible sequence associated with reactions has been ascertained. Thus it is evident that the mechanistic and vitalistic programs are, in so far as they pertain to experiment and observation, precisely the same. The mechanist holds that all reactions can be reduced to mechanical principles. Consequently he proceeds to ascertain by experimental methods every possible sequence of phenomena ending in reactions. The vitalists hold that some reactions or certain phases in some reactions can not be reduced to mechanical principles. He also must proceed to ascertain by experimental method every possible sequence of phenomena ending in reactions. For this is the only way he can be certain as to where mechanism breaks down and non-material factors begin to act.

But mechanists frequently maintain that faith in vitalism tends to inhibit experimentation, and that it inculcates superficiality. They maintain that when the vitalist gets into

difficulty he merely calls in some one of his numerous entelechies, psychoids, vital elans and what-nots to settle the matter in place of exerting himself to trace the source of the difficulty to changes in material configuration. There probably is some truth in this contention; but one thing is certain: that is, that not all vitalists are superficial experimentalists and slovenly observers, *e. g.*, Mendel, Müller, De Candolle, Driesch, Haldane.[2] Nor are all who profess to be mechanists proficient investigators.

Personally I do not believe that there is necessarily any essential difference between the mechanistic and the vitalistic doctrines in so far as they may affect investigation in behavior. I do not see how any one, no matter what doctrines he may hold, can fail to believe that some sequence in changes in material configurations ending in reactions have been ascertained, and that more such sequences can be ascertained, and if one believes this and holds that such knowledge is important, he has the same incentive to investigate regardless as to whether he is a mechanist, a vitalist or an agnostic.

The fact that many series of phenomena have in part been ascertained strongly favors the mechanistic view. This doctrine rests on positive experimental results, while the anti-mechanistic doctrine is founded largely, if not entirely, upon negative results. But there are, nevertheless, some difficulties involved in accepting without limitation the mechanistic doctrine. These difficulties, it seems to me, should be more fully comprehended than they appear to be. I shall, therefore, briefly refer to some of them.

It has often been maintained that the object of all scientific endeavor is the control of nature. While many hold that this statement is too strong, that the control of nature is not the only scientific problem worth while, it is quite generally conceded that it is among the most important problems. If the sequence of natural phenomena is known and if the probable sequence can be predicted, human activities, it is maintained, can be so adjusted as to fit in with the sequence of environmental phenomena, so as to reap pleasure and avoid disaster and, moreover, it is maintained that the sequence can be altered at will, and that nature can be made to obey the commands of man. "Truth makes us free," says Brooks in substance, because it teaches us how to adapt our responses to the order of nature and how to alter the order of nature to meet our demands. Man has harnessed the waters and chained the lightning, he has bridged the oceans and conquered the air. Who can say that he has not gained control over nature? But does this not imply freedom and is freedom not absolutely opposed to mechanism? Are we really free or do we merely think we are free?

Mechanism implies,[3] as previously pointed out, that every phenomenon is specifically associated with changes in the special interrelationship of material particles, masses or systems, changes in or states in material configurations, which are absolutely determined by preceding changes or states in material configuration. Consequently, if mechanism holds, every phenomenon, every act of every organism that ever existed, exists now, or ever will exist, is absolutely determined with reference to character, time and place and has been thus absolutely determined from the very beginning. If you can in reality, at any given instant, move your hand either to the right or to the left, mechanism breaks down, for according to the laws of mechanics, if you move your hand to the right, that movement is by the material configuration within and about you absolutely determined with reference to place, extent, duration and time and you could not possibly have moved it to the left at that time.

In discussing the question of design with Gray, Darwin implies that it is nonesense to believe, that when a swallow snaps up a gnat, it was designed that that particular swallow should snap up that particular gnat at that particular instant. It may be nonsense to be-

[2] Haldane should be classified as an anti-mechanist rather than as a vitalist.

[3] The following statements, of course, apply, in essence, to all deterministic doctrines, antimechanistic as well as mechanistic, as for example Driesch's vitalism.

lieve that all this was designed, but if the doctrine of mechanism holds, and Darwin is usually supposed to have been a mechanist, it has been, by series of material configurations which extend back to the beginning of time, absolutely determined for every swallow that ever existed or ever will exist, precisely which gnats he shall snap up and precisely when he shall snap up each particular gnat. If mechanism holds, chance does not exist in the commonly accepted sense of the term, and the statement so often made that this or that structure or phenomenon originated by chance or the fortuitous concourse of atoms indicates that the import of the mechanistic doctrine is not fully comprehended, for according to this doctrine every movement of every atom, every atomic configuration is absolutely determined by preceding movements or configurations and no other movements or configurations are possible.

If mechanism holds without limit, it is idle nonsense to talk about what might have been. The great calamity that has befallen the world, spreading misery as far as east is from west, threatening to ruin civilization, was scheduled before the world was. And if this is true, is it not sheer folly to hold this or that individual. whose every act is absolutely determined, responsible for the calamity? If mechchanism holds, we are merely cogs in a machine, nothing more, and freedom is a sort of epiphenomenon that exists only in the ethereal realms of philosophical speculation. Do not misunderstand me, I do not maintain that no one is responsible for the war; *far from it!*

I do not know to what extent the mechanistic doctrine is valid; all reaction may possibly be absolutely determined by material configurations; but I do know that I act as though I could, in a measure, regulate the order of phenomena about me, and my actions so as to harmonize with this order in such a way as to receive pleasure and avoid pain and disaster. And I believe that in view of the difficulties involved and in the present state of our knowledge, the general acceptance of this doctrine, without restrictions, is not advisable, because I think that, like all fatalistic doctrines, it would perniciously affect human conduct.[4]

Has then the attempt to reduce animate reactions to mechanical principles been a failure? It has been a failure in the sense that all science has been a failure. The purpose of science is to ascertain and to regulate the order of phenomena in nature; to ascertain in series the sequence of changes in material configurations. In no such series have all the changes yet been ascertained and they probably never will be. We know in part and we prophesy in part. Engelmann proved that sudden reduction in illumination causes reactions in *Euglena,* which result in the formation of dense aggregations in strong light. Lubbock discovered certain definite relations between wave-length of light and reactions in *Daphnia* and various other organisms. Verworn found that various animals orient definitely in electric currents. Loeb showed that photic orientation in Eudendrium bears a certain relation to the quantity of light energy received. Jennings demonstrated that weak acids and various other substances induce reactions in *Paramecium,* resulting in the formation of aggregations by the so-called trial and error method. Parker discovered certain definite relations between the rate of vibration in the surrounding medium and reactions in fishes. All of these responses and innumerable others have been to a certain extent reduced to mechanics, for in all of them series of changes in material configuration ending in reactions have been ascertained.

The attempt to reduce animate responses to physico-chemical principles has resulted in evidence which proves conclusively that a great majority of such responsess if not all of them, are at least in a measure mechanically determined. To ascertain the extent of

[4] Many who read this article will doubtless conclude that the author is a vitalist. Such, however, is not the case. He believes that the evidence at hand does not, as yet, warrant a definite conclusion regarding the extent of the validity of either vitalism or mechanism, and he holds with Huxley that "assertion which outstrips evidence is not only a blunder, but a crime."

this determination is, I believe, one of the foremost, if not the foremost problem that confronts the behaviorist of to-day, regardless as to whether he is vitalistically, mechanistically or agnostically inclined. This problem may never be solved. The extent to which reactions are determined by material configurations will probably never be precisely ascertained. But our knowledge concerning this can certainly be greatly extended. Our observations and experiments have thus far been largely qualitative. Indeed, we have as yet scarcely begun to apply quantitative methods. In this direction there stretches out before us a vast unknown region full of great promises and enticing possibilities.

S. O. Mast
Zoological Laboratory,
The Johns Hopkins University

GEORGE JENNINGS HINDE

On the eighteenth of last March Dr. George Jennings Hinde, F.R.S., F.G.S., died, at the age of seventy-nine. No doubt in time some friend or associate of his will write a personal tribute to the man and his work; I can but speak as one who knew him through his published researches, and it is to these that I would call attention in this brief appreciation.

Hinde was a man who saw nature through a microscope. His life was devoted to the study of minute organic remains so that, as he said of himself, when other paleontologists went into the field armed with hammer and chisel to collect large specimens, he took with him only a magnifying lens.

In the early seventies Hinde, having completed his preliminary education in England, came to Canada where he spent seven years at the University of Toronto under Professor H. A. Nicholson. During that period his researches were more primarily geological than paleontological, his most important contributions dealing with glacial phenomena in western Canada, the glacial and inter-glacial strata of Scarboro Heights and other localities near Toronto, and the terraces of Lake Ontario. But while studying these broader geological problems he was already turning his attention to the well-nigh invisible contents of the rocks. Near Toronto he discovered in the Ordovicic strata conodonts and annelid jaws, while in the Devonic of Eighteen Mile Creek, near Buffalo, New York, he discovered the now famous Conodont bed. Later he found similar annelid remains in the Siluric of western England and in the Lower Carboniferous rocks of Scotland.

Shortly after his return to England, he set out for what was then the paleontological Mecca of Europe—the University of Munich. Karl A. von Zittel had been called to the chair of paleontology at Munich in the early seventies and in less than a decade his fame as a teacher and original investigator had spread throughout the world. His first major contribution to science was his monograph on fossil sponges which appeared between the years 1878 and 1880. In this he laid the foundations of the science of paleospongiology, for he introduced the method of microscopic study of the spicules and skeletal structure, a method which had previously been deemed of no value for fossil forms although it was used for recent sponges. Furthermore, on the basis of these microscopic observations, he made a new classification of the whole phylum, redefined the old genera and described a large number of new ones, covering in this way the whole field of fossil sponges, and, finally, he gave an excellent series of illustrations of the spicules, a thing which had not been done before.

It was during this very period, when Zittel was annually publishing contributions on the structure and classification of sponges, that Hinde went to Munich where he rather naturally undertook, for his doctorate dissertation, a piece of work along the lines then being pursued so eagerly at that university. He had brought with him from England a small nodule from the Chalk of Horstead, in Norfolk, and this supplied him with material for his thesis, for, although the nodule measured only about a foot in diameter, it was found to contain thirty-eight species of sponges, all represented by spicules. These species, many of them new, were described and figured by Hinde in a paper published in 1880, entitled "Fossil Sponge Spicules from the Upper Chalk."

The completion of this piece of research on sponges marked a turning point in Hinde's life. From that time until his death, while he at intervals wrote short papers on other subjects, he devoted himself almost exclusively to the description of the fossil sponges of Great Britain. After receiving the degree of doctor of philosophy at Munich, Hinde was asked by the Keeper of the Geological Department of the British Museum to arrange the large collections of fossil sponges. At first it was thought that the task would not be very difficult but, on account of the necessity of making a microscopic study of the spicules of every specimen and of redescribing each species in scientific terms, it was found that a considerable period of time and extra financial support would have to be allowed for the research, and it is gratifying to note that neither appreciation of the value of such work nor money for its carrying on was lacking. As a result, there appeared in 1883 a quarto volume bearing the title "Catalogue of the Fossil Sponges in the Geological Department of the British Museum." But this was no mere catalogue, no mere listing of numbered specimens with a word or two of description, it was a masterly treatment, the first one of its kind in English, on the anatomy, structure, classification and distribution of fossil sponges, accompanied by illustrations of entire specimens and skeletal elements of all of the more important Paleozoic and Mesozoic genera of sponges in Great Britain, and the work was made particularly valuable by the addition of notes on the occurrence of the British species in other European localities, so that one may learn also of the faunal distribution of the sponges and the stratigraphic correlation of their horizons. The types of a large number of species founded by such early workers as Mantell, Toulmin Smith, Phillips and Miss Bennett were refigured and redescribed so that one need no longer rely upon the unscientific protologs and superficial photographs given by these and other authors. Hinde used Zittel's classification and adopted his method of study of spicules throughout the work, giving to the world a monograph which will always remain a standard work of reference. In recognition of his service to science in carrying on these elaborate researches the Geological Society of London in 1882 awarded to Hinde the Wollaston "Donation Fund."

The "Catalogue" was, however, only a rather general work covering the sponges of all periods. Hinde next undertook the detailed study of all British species in successive geologic systems. Thus, in 1887 he published in the Paleontographical Society (Vol. XL., 92 pp., 8 plates) the first part of "A Monograph of the British Fossil Sponges." It was the first treatise in any country to contain a résumé and evaluation of the literature on fossil sponges, two hundred and thirty-two papers and books being cited. In addition, it included a careful discussion of the structure and morphological characters of sponges, as well as a description of the types of spicules, and to-day this remains the only book in English where such features are found adequately described. The remainder of this first part and all of the second part (published in 1888) were devoted to the systematic description of the Paleozoic species of Great Britain and the figuring thereof. In 1893 a similar volume (part III.) was published covering the Jurassic sponges, and it was Hinde's intention to take up the very large Cretaceous fauna in the same way. But, unless this fourth part has appeared within the last year or so and copies of it have not yet reached this country, the monograph has not been completed and the most abundant, the most perfectly preserved of the sponge faunas of Great Britain must wait until some new worker appears to carry on this difficult task in a field where only a specialist of first rank would have the temerity to follow such a leader.

In 1897 Hinde was honored a second time by the Geological Society of London which awarded to him the Lyell Medal with the sum of twenty-five pounds in recognition of his researches in geology and paleontology and especially of his discoveries of fossil sponges and other minute organisms. Previously in 1886, he had been made one of the assistant editors

of the *Geological Magazine*, an office which he held until his death

Among his lines of research other than those on sponges may be mentioned those on the fossil radiolaria from the rocks of Central Borneo, on the borings in the Funafuti Atoll, on the Cretaceous entomostraca of England and Ireland, and on the annelid remains in the Siluric of Gotland and in numerous other formations of the New and Old World. But despite the value of these investigations, Hinde's name will always be most closely associated with the development of the science of palaeospongiology. What Zittel did for fossil sponges as a group, Rauff for the Paleozoic species of the world, Počta for the Cretaceous sponges of Bohemia, Kolb for the Jurassic and Schrammen for the Cretaceous of Germany—all this Hinde undertook and largely completed for paleospongiology in Great Britain. His death not only deprives England of an eminent paleontologist, but it takes from the science of paleospongiology one of its founders—a man who for four decades devoted his time to the elucidation of the diverse problems connected with the anatomy, taxonomy and geologic occurrence of a group of fossils of which practically nothing was known fifty years ago.

Marjorie O'Connell

American Museum of Natural History

INQUIRY OF THE AMERICAN GEOGRAPHICAL SOCIETY FOR THE INFORMATION OF THE PEACE COMMISSIONERS

In September, 1917, as a result of conferences between Colonel E. M. House and President Wilson, Colonel House was authorized to organize forces to gather and prepare for use at the Peace Conference the most complete information possible, from the best and latest sources, for consideration by the Peace Commissioners.

The expenses were provided for from the special emergency fund placed by Congress at the President's disposal.

Colonel House held preliminary conferences with Dr. S. E. Mezes, president of the College of the City of New York; Professors James T. Shotwell, of Columbia University, and Archibald C. Coolidge, of Harvard University, about the broad lines of the work, and its organization, which, after a time, became known officially as "The Inquiry."

It was soon evident that the scope of the inquiry would demand not only a personnel of size and quality hitherto unknown in any such work but headquarters where safety from enemy activity of records and secret documents could be assured. "The Inquiry" has worked in the closest touch with the Military Intelligence Division. There was also needed an already established organization for many kinds of research, mapmaking, etc., which could be immediately utilized. This problem was finally solved when the American Geographical Society placed its building, at 156th Street and Broadway and a part of its staff, including its director, Dr. Isaiah Bowman, at the disposal of "The Inquiry" without cost.

The work from that date, November 10, 1917, got really under way, and has proceeded under careful guard night and day. Such measures were considered vital, owing to experiences at other peace conferences, notably that after the Franco-Prussian war. It was considered necessary, too, to abstain from publication of details of the work of "The Inquiry" until its results were safely on shipboard. A large part of them are now on the way to Europe, and by the time the President, the other peace commissioners and their staffs, together with the twenty-three members of "The Inquiry," arrive in France, the material used will be ready for them. The main body of it left the building of the American Geographical Society in three army trucks on Monday, December 2. Other results of the work are already in Paris, where Colonel House has been arranging the preliminaries of the forthcoming conference.

Similar inquiries have been in progress abroad, notably in France and England. There have been frequent conferences for delivery of material and exchange of views, marked by a spirit of friendly cooperation

throughout. Some of the material from Europe, such, for example, as the complete texts of important treaties signed since the beginning of the war, has never been made public.

Primarily, "The Inquiry" has been a fact study, conducted in a scientific spirit by specialists and scholars, both American and from various European countries affected by the war. In order to give high value to any statement of fact, the inquiry has been entirely independent of any political hypothesis.

"The Inquiry" has had a personnel of about 150 people. Among them are:

Director, Dr. S. E. Mezes, president of the College of the City of New York.

Chief Territorial Specialist, Dr. Isaiah Bowman, director of the American Geographical Society.

Specialist on Economic Resources, Allyn A. Young, head of the department of economics at Cornell University.

Charles H. Haskins, dean of the graduate school of Harvard University, specialist on Alsace-Lorraine and Belgium.

Clive Day, head of economics department at Yale, specialist on the Balkans.

W. E. Lunt, professor of history, Haverford College, specialist on northern Italy.

R. H. Lord, professor of history at Harvard, specialist on Russia and Poland.

Charles Seymour, professor of history at Yale, specialist on Austria-Hungary.

W. L. Westermann, professor of history at the University of Wisconsin, specialist on Turkey.

G. L. Beer, formerly of Columbia University, specialist on colonial history.

Cartographer, Mark Jefferson, professor of geography, Michigan State Normal College.

Roland B. Dixon, professor of ethnography at Harvard.

In addition there are eleven assistants and four commissioned officers of the Military Intelligence Division assigned to the inquiry for special problems on strategy, economics and ethnography. These officers are:

Major D. W. Johnson, Columbia University.

Major Lawrence Martin, University of Wisconsin.

Captain W. C. Farabee, the University Museum, Philadelphia.

Captain Stanley Hornbeck, author of "Contemporary Politics in the Far East."

The above named, together with map makers and other assistants, sailed with the Peace Commission on the *George Washington*.

Passing by the countless details, "The Inquiry," broadly, has covered the following fields:

1. *Political History*—
   - (*a*) Historic rights, including suffrage laws.
   - (*b*) Religious development and customs.
   - (*c*) Rights of minority peoples in composite populations; subordinate nationalities.
2. *Diplomatic History*—
   - (*a*) Recent political history related to diplomacy, treaties, etc.
   - (*b*) Public law, constitutional reforms, etc.
3. *International Law*—
   - (*a*) To lay the groundwork toward bringing the subject up to date.
   - (*b*) Study of treaty texts since the beginning of the war.
   - (*c*) Geographical interpretation of problems of territorial waters, frontiers, etc.
4. *Economics*—
   - (*a*) International: raw materials, coaling stations, cable stations, port works, tariffs and customs unions, free ports, open ports.
   - (*b*) Regional: industrial development, self sufficiency, traffic routes in relation to boundaries and material resources, including food, minerals, water power, fuel, etc.
5. *Geography*—
   - (*a*) Economic geography.
   - (*b*) Political geography.
6. *Physiography*—
   - (*a*) Strategic frontiers.
   - (*b*) Topographic barriers.
7. *Cartography*—Maps to illustrate every kind of distribution that bears on peace problems, such as: (*a*) Peoples, (*b*) Minerals, (*c*) Historical limits, (*d*) Railways and trade routes, (*e*) Crops and livestock, (*f*) Cities and industrial centers, (*g*) Religions.
8. *Education*—
   - (*a*) Status in colonial possessions.
   - (*b*) In backward states.
   - (*c*) Opportunities of oppressed minorities.
9. *Irrigation*—
   - (*a*) Present development.
   - (*b*) Possibilities in general reconstruction.

In its latest stages "The Inquiry" had its work centered on territorial matters, so that all the specialists going abroad are territorial specialists, except the direct representatives of

the State Department. Part of the force in international law are already in Europe, including David H. Miller, chairman of the law committee of the State Department.

Every important nationality of Europe and western Asia has had representatives here for conference with "The Inquiry." Authorities native to the affected countries in Europe have lent their aid and have placed at the disposal of the "Inquiry" all sources of information in their native languages. These, together with numerous secret documents and much information hitherto unavailable to scholars, has resulted in a bibliographic collection altogether unique and valuable. It will become part of the records of the State Department.

The cartographic force of the American Geographical Society, greatly augmented by government aid, began a map-making program hitherto without precedent in this country, all work being carefully drawn from the latest and best sources. Maps have been made to visualize not only all manner of territorial boundaries, but distribution of peoples, number and local densities of population, religions, economic activities, distribution of material resources, trade routes, both historic and potential strategic points.

A series of base maps and block diagrams, the most nearly complete series existing, has been prepared by the American Geographical Society, bearing upon all the geographical problems both of the war and the peace which is to follow. This series has been adopted by the War Department and prescribed by its Committee on Education and Special Training for use in all colleges and other centers where units of the Students' Army Training Corps are located, and for use by chairmen of the War Issues Course Groups. Many of these base maps and block diagrams have already been procured by colleges and universities.

Upon these base maps the Peace Commissioners, or others, by use of colored lines, may immediately have a map showing new state lines, ethnic boundaries, a rectified frontier, or a distribution of any sort, and at the signing of the treaty of peace, a complete record of the new map of Europe.

All information gathered by "The Inquiry" has been so carefully classified, indexed and subdivided that it will be instantly available.

The library for the commissioners will also include hundreds of maps and books from the American Geographical Society, from Harvard, Princeton, Haverford College, the Library of Congress and the New York Public Library. These, with the data gathered by the inquiry have been constantly under guard.

The American Geographical Society will prepare, under the supervision of its director, Dr. Isaiah Bowman, a complete history of the work of "The Inquiry." A history of it will also be prepared for the History Board of the War Plans Division of the General Staff of the War Department.

President Wilson visited the headquarters of "The Inquiry" on October 12, on which occasion he registered his name on the wall in the office of the director of the American Geographical Society. Immediately under it are the names of Secretary Lansing, who visited the "Inquiry" on two occasions, and of Colonel House.

During the year there were a large number of other distinguished visitors, including Secretary Houston, Governor McCall and Major Requin, for a time General Foch's Chief of Staff. The last-named, at the time of his visit, constructed a blackboard sketch of the first battle of the Marne, and this, now carefully preserved, has great historical interest.

SCIENTIFIC EVENTS

THE SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY[1]

The Salters' Company has during many years given evidence of its interest in the promotion of scientific education and research by the provision of fellowships tenable by post-graduate workers. It has now taken a further very important step in announcing a scheme for the establishment of an institute to be called "The Salters' Institute of Industrial

[1] From *Nature*.

Chemistry." The offices of the institute will be for the present at the Salters' Hall, and the scheme will be administered by a director, who will be selected on the ground of qualifications based on a distinguished academic career in chemistry coupled with extensive technical experience. An Advisory Board composed of representatives of the Salters' Company, the universities, and the Association of British Chemical Manufacturers is also under consideration.

The Company proposes to establish two types of fellowship, for which post-graduate students of British nationality will be eligible whether graduates of a British university or of a university in the United States or elsewhere. They are to be (1) fellowships to enable post-graduate students to continue their studies at an approved university or other institution under the general supervision of the director of the institute, and (2) industrial fellowships to enable suitably equipped chemists to carry on research for any manufacturer under an agreement entered into jointly by the institute, the manufacturer, and the fellow.

It will be observed that the Company does not at present contemplate the erection of any building or the equipment of any laboratory. Its aim is, therefore, somewhat different from that of the founders of such estalishments as the Davy-Faraday Laboratory attached to the Royal Institution in London, or the Kaiser Wilhelm Institute opened in 1912 near Berlin. The intention is to add to the number of first-rate chemical technologists available for the service of industry in this country, a class of men which at present scarcely exists and is sorely needed. It is hoped to offer such attractions to some of the best students that on completing their university course they will seek to apply their knowledge to manufacture and industry generally, and that employers will recognize promptly the necessity for such assistance so that openings for such men with suitable remuneration will be provided concurrently with the supply. Hitherto almost the only career available for the honors graduate in chemistry has been in connection with the teaching profession. Probably in future such men will be divided into two classes according to their personal predilections, some going to the works, while others will prefer teaching. In both directions the opportunities provided have been insufficient in number and inadequate in remuneration, so that many cases have occurred in which a man with distinct scientific gifts has been forced by circumstances to seek employment in other directions, and science has been consequently the poorer.

The fundamental idea which has inspired the Salters' Company may be illustrated by one or two examples. Suppose a man to have taken his degree with distinction in chemistry, and in physiology as a second subject. Elected to a Salters' fellowship, he may undertake a research on some subject of a biochemical nature. This may be carried on at his own university or at any other possessing a special school for this class of work in England or some other country. In due time arrangements may be made by the director for the fellow to take a course of chemical engineering, perhaps in America, and afterwards to obtain technical and industrial experience. In a very short time a man so trained and experienced will be in a position to demand, and will certainly be worth, a very high salary. It would be easy to provide a similar course with the necessary modifications adapted to the case of a man whose original bent is in the direction of physical chemistry or pure organic or metallurgical chemistry. The printed scheme issued by the Salters' Company gives no information as to the pecuniary value of the proposed fellowships. In estimating the annual amount which should be assigned to each fellowship, it must be remembered that the holder, while required to live simply and carefully, must be free from difficulties about books, traveling expenses and laboratory outlay. Probably £300 a year under present conditions and for some time to come will not be found too much, though perhaps expenses will depend to some extent on whether the student remains at home or is required to reside at a foreign university or center. When operations are to commence at the institute will depend

on the discovery of the right man for the office of director, and doubtless he will have a good deal to say about working details.

THE INFLUENZA EPIDEMIC

The Bureau of the Census has supplied the following data concerning deaths from influenza and pneumonia covering twelve weeks ending September 14 to November 30, inclusive.

Cities in Order Affected	First Week	Maximum Week	Week when Death Rate (all Causes) Reached Normal Level	Deaths from Influenza and Pneumonia (all Forms)	
				Number	Number for 1,000 Population
Boston	Sept. 14	4th	10th	4,510	5.7
Worcester	" 21	"	9th	919	5.3
Lowell	" 21	"	8th	534	4.9
Fall River	" 21	"		704[1]	5.5
Providence	" 21	5th	10th	1,086	4.1
New York	" 21	6th		21,314	4.1
Cambridge	" 28	2d	7th	504	4.5
Syracuse	" 28	4th	9th	915[1]	5.7
New Haven	" 28	5th		783[1]	5.1
Washington	" 28	4th	8th	2,082	5.2
Jersey City	" 28				
Pittsburgh	" 28	7th		3,710	6.3
Philadelphia	" 28	4th	9th	13,025	7.4
Indianapolis	" 28	"		584[1]	2.0
Chicago	" 28	5th		9,133	3.5
Buffalo	" 28	"	9th	2,293	4.8
Baltimore	" 28	4th		3,812	6.4
Milwaukee	" 28	5th		821	1.8
Minneapolis	" 28	"		671[1]	1.7
Birmingham	" 28	"	7th	622	3.1
Newark	" 28	"		1,873	4.4
Richmond	Oct. 5	3d		667	4.2
Kansas City	" 5	5th		1,085	3.5
New Orleans	" 5	4th		2,134	5.6
Denver	" 5	"		962	
Louisville	" 5	"	7th	735	3.0
Columbus	" 5	"		526	2.3
Cincinnati	" 5	"		1,280	3.1
Nashville	" 5	3d		620	5.2
Atlanta	" 5	4th	5th		
Los Angeles	" 5	5th		1,877	3.3
Cleveland	" 5	"		2,686	3.3
Albany	" 5	4th	8th	592	5.3
Memphis	" 5	3d	7th	534[1]	3.4
Omaha	" 12	2d		527[1]	2.9
St. Paul	" 12	6th		624[1]	2.4
Seattle	" 12	3d		703	
Dayton	" 12	"	6th	533	4.1
Rochester	" 12	"		808	3.1
St. Louis	" 12	4th		1,714	2.2
Oakland	" 12	"		702[1]	3.3
Grand Rapids	" 12	6th		128[1]	0.9
Spokane	" 12	3d		233[1]	
Portland	" 12	4th		676	
San Francisco	" 12	"		2,247	4.7
Toledo	" 12	3d		523	2.0

[1] Deaths for eleven weeks only.

THE RETURN OF CHEMISTS TO THE INDUSTRIES

When the United States entered the European war one of the first problems to be considered was the effect of the draft upon our essential industries. It was early appreciated that in order to maintain our full efficiency it would be necessary to conserve as far as possible our skilled workers and men with technical training. In order that we might not suffer from the depletion of our ranks, steps were taken to secure deferred classification, and later on provision was made to furlough back to industry. This arrangement made it possible for chemical industries to maintain their efficiency and has contributed largely to the effectiveness of our forces in the field.

Up to the time of cessation of hostilities the Industrial Relations Branch of the Chemical Warfare Service had recommended for deferred classification 641 chemists and skilled workers. These recommendations were favorably considered, as a rule, by the local boards, and as a result about 90 per cent. of the men so recommended were put in a deferred class.

Many cases, however, were not brought to the attention of this branch until the men had actually been called into service. Such chemists or skilled workers as were essential to industry were then furloughed in order that the production of war materials might not be retarded. Through this method 156 men had been returned to industry, and at the time of the signing of the armistice 120 more cases were pending in the Adjutant General's office.

As hostilities cease we naturally must again turn to peace-time conditions and look forward to the future development of chemical industry in America. The problem now before the Industrial Relations Branch of the Chemical Warfare Service is to assist chemists in service to secure positions where their training and experience can be used to the best interests of the government. This enormous readjustment is rendered possible through the information gathered by Dr. Charles L. Parsons, secretary of the American Chemical Society, and through the questionnaires sent out by Major

F. E. Breithut, of the Personnel Division of the Chemical Warfare Service.

In order to accomplish results the chemists now in military service who desire to return to chemical industry are being requested to inform the chief of the Industrial Relations Branch concerning their future prospects, while the manufacturers are being asked to designate their requirements for chemists. The administration of this work will be carried out by the Industrial Relations Branch. Any information desired may be obtained by writing to Major Allen Rogers, Chief, Industrial Relations Branch, Chemical Warfare Service, 7th and B Streets, N.W., Washington, D. C.

THE AMERICAN PSYCHOLOGICAL ASSOCIATION

AFTER the signing of the armistice, the council reconsidered its vote not to have a meeting this year. It has been definitely decided to hold a brief and somewhat informal meeting at Baltimore. The Baltimore meeting will be held on Friday and Saturday, December 27 and 28. The sessions will take place in Gilman Hall, Homewood, Johns Hopkins University. Sections H and L of the A. A. A. S. will meet in rooms in the same building.

The program has been limited to papers upon psychological work in connection with the war. Owing to the short time at the committee's disposal, it has asked a number of members in service to present papers, instead of following its usual custom of sending a general notice to the members of the association. A number of members have already consented to read papers, and the meeting promises to be an interesting one. The general scheme for the program is as follows: Friday, December 27, at 10 A.M.—a parallel session with Sections H and L; Friday afternoon—a joint session with Sections H and L; Friday at 6:33—the annual dinner followed by a business meeting and smoker; Saturday morning at 9:30—a joint session with Section H; Saturday afternoon—a symposium upon "The future of pure and applied psychology." Friday at 4:30 P.M., Professor E. L. Thorndike, the retiring vice-president of Section H, A. A. A. S., will deliver an address entitled, "Scientific personnel work in the U. S. army." At 7:30 P.M., Professor E. F. Buchner, the retiring vice-president of Section L, will deliver an address entitled, "Scientific contributions of the Educational Survey." Among others, will be papers upon the work of the psychological examiners, upon the methods of the Committee on Classification of personnel including the trade tests, upon the work of reconstruction and upon the investigations in connection with aviation. It will not be possible this year to send a complete program to the members before the date of the meeting. All members are invited to attend the smoker, whether they are present at the dinner or not.

H. S. LANGFELD,
Secretary

HARVARD UNIVERSITY,
December 4, 1918

THE YELLOW FEVER EXPEDITION OF THE ROCKEFELLER FOUNDATION

DR. GEORGE R. VINCENT, president of the Rockefeller Foundation, announces that with the cessation of hostilities in France the foundation is prepared to direct its activities, largely diverted into war channels, back into ways of peace. Its international health board, he said, would renew at once in cooperation with local authorities in South and Central America its combat against yellow fever.

Dr. William C. Gorgas, retired from the post of surgeon general on account of age, soon will sail, to take charge of the foundation's fight against yellow fever. The position of director of yellow fever work, which General Gorgas now occupies, he held until the war compelled him to relinquish it and the foundation to suspend its efforts. Dr. Vincent's statement continues:

> Dr. Gorgas will sail within a short time for Central and South America. Dr. N. E. Connor has already preceded him to Guayaquil, on invitation of the government of Ecuador. He will guide the local operations, which will be done by men appointed by the local authorities.
>
> The program which General Gorgas will now actively develop, results from a study of the yellow fever problem by the International Health board, which began its labors in July, 1914.

The opening of the Panama Canal, with the establishment of new world trade routes, brought the danger of a wide distribution of yellow fever. Its appearance in Asia, for example, would be a catastrophe.

To obtain authoritative information and counsel, the board appointed a yellow fever commission, headed by General Gorgas. Associated with him were Dr. Henry R. Carter, of the United States Public Health Service; Dr. Juan Guiteras, chief health officer of Havana; Major T. C. Lyster and Major E. R. Whitmore, of the Medical Department, United States Army, and Mr. W. D. Wrightson.

To define the problem accurately, the commission, in the spring and summer of 1916, visited all countries in South America in which yellow fever had appeared in recent years. On its return it presented a report, expressing the opinion, in which all members of the commission concurred, that the total eradication of yellow fever was feasible.

In January, 1917, the board adopted a working program and appointed Dr. Gorgas director. The Secretary of War had agreed to release the surgeon general for this service, but the war compelled a postponement of the work which is now to be resumed.

SCIENTIFIC NOTES AND NEWS

Raymond Dodge, professor of psychology in Wesleyan University, has been made lieutenant commander in the United States Navy, in recognition of the special psychological tests devised by him for the use of the Navy during the war.

Dr. Charles S. Venable is a captain in the Development Division of the Chemical Warfare Service doing gas offense work in Cleveland.

Professor E. C. Franklin, of Stanford University, is on leave of absence and is engaged in research work near Washington for the Nitrate Division, Ordnance Department of the Army.

Eight American engineers have sailed for France to attend the French Engineering Congress in Paris to study reconstruction in France and restoration of French industries. An invitation to send representatives to the meeting was received by the American Society of Civil Engineers from the French Society of Civil Engineers, and the American organization invited representation from the national societies of civil, mechanical, electric and mining engineers. The members of the delegation are: George F. Swain, Nelson P. Lewis, George W. Fuller, A. M. Hunt, George W. Tillson, Major James F. Case, L. B. Stillwell and E. Gybbon Spilsbury.

Dr. Astley P. C. Ashhurst, of Philadelphia, who went to France as a major in command of Base Hospital No. 34, unit of the Episcopal Hospital, has been promoted to the rank of lieutenant-colonel and placed in charge of all the hospitals in the Mantes Sector. His place as director of Base Hospital No. 34 has been taken by Dr. Emory G. Alexander.

Major J. C. Fitzgerald, director of Connaught and Antitoxin Laboratories, University of Toronto, is at present with the Royal Army Medical Corps, as officer-commanding, No. 39 Mobile Laboratory, France, and acting also as adviser in pathology.

Dr. I. M. Lewis, formerly chairman of the school of botany in the University of Texas, is now a captain in the Sanitary Corps, stationed at Yale University. He is in charge of the preliminary course given to officers in training at Yale University.

Lieutenant Alvin R. Lamb, of the Division of Food and Nutrition, Medical Department, U. S. Army, is now stationed at Camp Greenleaf, Ga. He is on leave of absence from the Iowa Agricultural Experiment Station.

Lieutenant Ralph Benton, Inf., U. S. A., formerly associate professor of zoology in the University of Southern California and more recently of the United States Bureau of Biological Survey, has been assigned as personnel adjutant at the College of the Pacific, San Jose, Calif.

The following men, formerly members of the scientific staff of the Bureau of Biological Survey, U. S. Department of Agriculture, are now engaged in rat-control work in connection with the Sanitary Corps of the American Army in France: Major Edward A. Goldman, in charge, assisted by Lieutenants Francis Har-

per, Joe G. Crick and Joseph Keyes, and Sergeant Remington Kellog.

DR. KENYON L. BUTTERFIELD, president of Massachusetts College and member of the Army Educational Commission for Vocational Training, has sailed for France to begin work in the overseas schools which are to be open to soldiers until they return home.

DEAN HAYWARD, of the Agricultural Department of Delaware College, has been given a leave of absence for a year to serve as a regional director of agricultural education in France, under the Y. M. C. A. army overseas educational commission.

PROFESSOR HARRY FIELDING REID, of the Johns Hopkins University, and Professor Stephen Faber, of the University of South Carolina, have gone to Porto Rico, at the request of the Secretary of War, to study the severe earthquakes which did serious damage in that island in October.

DR. EDGAR W. OLIVE, curator at the Brooklyn Botanic Garden, spent several weeks during the past summer for the Plant Disease Survey and Cereal Disease Office of the United States Department of Agriculture, in cooperation with the departments of plant pathology of the New York State Agricultural College, Cornell University, and the Virginia Polytechnic Institute. The work included a fruit disease survey of the counties in the Hudson River valley; a study of onion smut conditions in the Wallkill valley, Orange county, N. Y.; an oat and barley smut trip through the Hudson River valley counties, and a study of a new wheat disease in western Virginia. This work was continued during October, Dr. Olive being in Pennsylvania from the first to the fifth of the month, making a survey and study of a new and descriptive potato wart disease.

DR. ORLANDO E. WHITE, curator of plant breeding at the Brooklyn Botanic Garden, was granted a leave of absence of three and a half months, beginning on August 1, 1918, for the purpose of cooperating with the federal government in the study of various problems connected with the growth and utilization of the castor oil bean, with special reference to the production of castor oil. Plantations were visited in Tennessee, Arkansas, Georgia, Florida and Texas.

MR. G. W. GRAY, of the Midland Refining Company, El Dorado, Kansas, has been appointed a director of the Bureau of Refining, Oil Division, U. S. Fuel Administration.

PROFESSOR E. K. SOPER, of the Oregon State School of Mines, has returned to Corvallis, Oregon, after three months of geological work in the Atlantic Coast and Great Lakes States.

DR. W. W. BONNS has accepted a position as director of the botanical research department of Eli Lilly Co., pharmaceutical chemists, Indianapolis.

J. R. BAILEY, professor of organic chemistry in the University of Texas, who spent last year doing research work with the Hirsch Brothers in New York, has returned and resumed his duties at the university.

DR. C. STUART GAGER, director of the Brooklyn Botanic Garden, delivered the commencement address at the School of Horticulture for Women, Ambler, Pennsylvania, on December 13, 1918. The subject of the address was "Horticulture as a profession."

AT the recent opening at the South Baltimore General Hospital Dr. Llewellys F. Barker, of the Johns Hopkins University, and Dr. Jane E. Nash, superintendent of the Church Home and Infirmary, made the principal addresses.

THE anniversary address of the New York Academy of Medicine was delivered on December 5, by Edwin G. Conklin, professor of biology in Princeton University, on "The biology of democracy with especial reference to the present world crisis."

OVER £2,500 of the £12,000 required has been subscribed to the chair of medicine which is to be established in the University of Belgrade, as a memorial to D. Elsie Ingles.

DR. SIDNEY AUGUSTUS NORTON, emeritus professor of chemistry at Ohio State University since 1895, has died at his home in Columbus, aged eighty-four years. He was one of the five members of the original university

faculty appointed in 1873, of whom two—Dr. Tuttle, of Virginia, and Dr. Mendenhall, of Ravenna—now survive.

The temporary officers of the American Association of Clinical Psychologists have deemed it advisable to hold the annual meeting scheduled for December, 1918. The temporary officers of the association are as follows: Chairman, J. E. Wallace Wallin; Secretary, Leta S. Hollingworth; Committee on Constitution, Leta S. Hollingworth, David Mitchell and Francis N. Maxfield; Committe on nomination of officers and new members, Rudolf Pintner, Helen Thompson Woolley and H. H. Goddard.

During the past summer, the Gail Borden collection of minerals, belonging to Occidental College, Los Angeles, which had been loaned to the mining exhibit at the San Diego Fair, has been rearranged and placed in a better position for study. This collection containing some of the finest mineral specimens on exhibition in southern California, became the property of the college some years ago and forms the nucleus around which its mineralogical collections are grouped. Additions to these by gift and purchase have been made from time to time so that to-day the collection has representative series of most of the economically valuable minerals, especially those of the west. The collection is open to the public and facilities for study of the specimens will be extended to visiting mineralogists.

UNIVERSITY AND EDUCATIONAL NEWS

A step of much importance to Utah was taken by the Board of Trustees of the Utah Agricultural College on December 2, when they formally established an Agricultural Engineering Experiment Station as an integral part of that institution. Under the plan of organization there will be five experimental divisions of the new station under the following personnel:

Irrigation and Drainage: Dr. F. S. Harris and Professor O. W. Israelsen.

Roads: Professor Wm. Peterson and Ray B. West.

Farm Machinery and Transportation: Professor L. R. Humphreys.

Manufacture of Agricultural Products: Dr. M. C. Merrill and Professor J. C. Thomas.

Rural Architecture and Buildings: Professor R. B. West.

The governing board of the Sheffield Scientific School, Yale University, has decided, without a dissenting vote, to recommend the establishment of a four-year course in place of the present three-year course.

Dean E. A. Birge, professor of zoology, will continue to act as president of the University of Wisconsin until a successor is elected to the late President C. R. Van Hise.

Dr. Horace D. Arnold has been appointed director of the Harvard Graduate School of Medicine; Alexander S. Begg, dean, and Charles L. Scudder, acting dean. The other members of the administrative board chosen are: Drs. David L. Edsall, George G. Sears, Algernon Coolidge, Ernest E. Tyzzer and Francis W. Peabody.

Professor C. A. Wright, of the Iowa State College, has been appointed professor of electrical engineering, in the College of Engineering at Ohio State University.

DISCUSSION AND CORRESPONDENCE

A LEAGUE OF NATIONS

To the Editor of Science: Allow me to call the attention of your readers to the statement below, regarding a League of Nations.

Until a month ago the best that we could do was to "win the war." Now that the war is won, let us remember that it has been won for peace; and let us therefore do our utmost to prevent the recurrence of anything so utterly wasteful, so inanely unscientific as warfare as a means of settling international disputes. Is it not indeed unthinkable that we should again attempt to settle differences by a method, in which the demonstration of rightfulness consists so largely in discovering which nation or group of nations can kill or starve the greatest number of its opponents, and in which the

discoveries of science are reduced to their most cruel and malevolent application.

While we may not be able to specify the ways in which a League of Nations shall act to maintain peace, let us at least impress upon our government the essential importance of reaching the best possible understanding with other nations as a means of preventing future wars—in other words, the importance of forming the best attainable League of Nations for the maintenance of peace. We can not impress the government to this end in any way better than the truly democratic way of petitioning.

The precise form that a petition in favor of a League of Nations may take is of secondary importance, but it is of prime importance that the great body of public opinion which is so strongly in favor of permanent peace should make itself known to the government, and thus strengthen the purpose of those public servants who have this great end in view.

Let me note that six or more members of the National Academy, present at the Baltimore meeting, being officers in the Army and Navy, refrained from signing the following statement, because officers are not allowed to take part in such matters.

W. M. DAVIS

CAMBRIDGE, MASS.,
December 3, 1918

The undersigned members of the National Academy of Sciences, meeting in Baltimore, November 18, 1918, having petitioned the Congress of the United States to take action, in consultation with the governments of many other countries, toward the formation at as early a date as possible of a League of Nations for the maintenance of peace, hereby urge the members of other learned societies in the United States to do likewise.

CHARLES D. WALCOTT, Smithsonian Institution, Washington, D. C.

ARTHUR GORDON WEBSTER, Clark University, Worcester, Mass.

H. S. JENNINGS, Johns Hopkins University, Baltimore, Md.

DOUGLAS H. CAMPBELL, Stanford University, California.

VICTOR C. VAUGHAN, University of Michigan, Ann Arbor, Mich.

JOSEPH P. IDDINGS, U. S. Geological Survey, Washington, D. C.

WALDEMAR LINDGREN, Massachusetts Institute of Technology, Cambridge, Mass.

JOHN M. CLARKE, State Museum, Albany, N. Y.

WHITMAN CROSS, U. S. Geological Survey, Washington, D. C.

JOHN J. ABEL, Johns Hopkins University, Baltimore, Md.

W. M. DAVIS, Harvard University, Cambridge, Mass.

EDWIN G. CONKLIN, Princeton University, Princeton, N. J.

WALTER JONES, Johns Hopkins University, Baltimore, Md.

W. S. HALSTED, Johns Hopkins University, Baltimore, Md.

G. A. BLISS, University of Chicago, Chicago, Ill.

HENRY M. HOWE, National Research Council, Washington, D. C.

F. L. RANSOME, U. S. Geological Survey, Washington, D. C.

ERNEST F. NICHOLS, Yale University, New Haven, Conn.

W. H. HOWELL, Johns Hopkins University, Baltimore, Md.

EXPERIMENTAL OSMOSIS WITH A LIVING MEMBRANE[1]

IT was after an early killing frost some years ago that I cut down the dahlias before the sun could make effective its warmth of the early day. As the sickle passed through one of the large stems, water flowed out of the chamber between two nodes. A somewhat closer inspection revealed that fully half of the large chamber had been filled with water and that part of it had developed into long acicular crystals of ice. I was reminded of the advice given by an expert in dahlia culture, namely that, when the flowering period began, the plants should be given all the water they could stand. Ap-

[1] A personal communication to a former student.

parently, it was in these internodal chambers that the plants stored away what might be designated their reserve water supply. This observation has acquired new significance in the light of the statement made by Atkins that trees store away a supply of water as well as sugar in winter in the dead portions of the woody trunk and that these materials are drawn upon in the early spring for the new growth.

Interesting as this comparison may be in itself, the observation made on the dahlia, together with the peculiar stem structure of this plant, suggested the possible use of the internode with one of the nodes as an osmosis cell where the semipermeable membrane is a live tissue. Hence, I have been wanting to use it as such ever since, but failed to carry out the idea until this morning (October 3, 1918). Having cut down a stem, such a chamber or cell was easily prepared, a dilute salt solution introduced into the cell, the latter capped with a rubber stopper through which a tube was passed down into the cell, and the whole placed into a beaker with distilled water. It did not last long until the salt solution was seen to rise in the tube and at the end of possibly an hour it had risen fully six inches. Before another hour the salt solution had risen to the top of the tube.

A number of possibilities for further experimentation at once suggested themselves, but before going any farther, I thought it advisable to show the experiment to Professor Overton, our plant physiologist. He informed me that, so far as he knew, the experiment was a new one and asked for permission to show it to his class in place of the conventional thistle tube experiment. He called in two other members of the botany department who happened to be passing by. To them also the experiment was new.

Whether I shall be in a position to continue the line of investigation that suggests itself, especially during these times so hostile to research, I have my doubts. Nevertheless the mere possibility of studying osmotic problems, even greatly limited in range, with a living osmotic cell of such convenience as the dahlia internode and node, is stimulating in itself. It will involve not only chemical problems but a careful anatomical study of the tissues as well. Because of the great amount of reserve materials stored away in the roots, it ought to be an easy matter to raise this osmotic cell-producing plant in greenhouse for winter experimentation.

Edward Kremers
University of Wisconsin

QUOTATIONS

FRANCE'S SHARE IN BIOLOGY AND MEDICAL SCIENCE

A course of three lectures on France's share in the progress of science has been delivered at University College, London, by M. Henri L. Joly, professeur des sciences physiques et naturelles au Lycée Français. In the concluding lecture, on November 5, he dealt with biology and the medical sciences, but owing to the wide range of the subject, covering the achievements of at least three centuries, he professed that he could do little more than recite a list of names of greater or less distinction. After references to de Tournefort, Duhamel de Morceau, and Buffon, whom he regarded as a man of letters rather than an exact naturalist, he said that the founder of modern biology in France was Lamarck, who first sought in natural sciences for something beyond description and classification. Xavier Bichat was a pioneer in histology and did much valuable work on the cellular theory. Cuvier was declared to be the greatest of French comparative anatomists, and other naturalists mentioned were Gaudry, one of the early evolutionists; Van Tieghem, to whom very Frenchman studying botany acknowledged a debt; J. H. Fabre, who had done more than any man to popularize natural history in France; Armand Sabatier, the comparative anatomist, and Lecoq, who, the lecturer contended, had anticipated Mendel by twenty years. Turning to Frenchmen whose work had been more particularly in the sphere of medical sciences, after mentioning Mondeville and Guy de Chauliac, M. Joly passed on to the seventeenth century, noting the work of Pecquet on the thoracic duct, of Paris on

ergotism, and of Denys, who performed transfusion of the blood in Paris in 1667. Descartes, who was chiefly known in other scientific connections, did some useful work on visual accommodation, and Lavoisier made a contribution to the chemistry of respiration. He spoke next of Laënnec, of Magendie, who was probably the first experimental pharmacologist; of Le Gallois, who worked on the vagus nerve; of Flourens, who first used chloroform in experiments on animals; of Claude Bernard, who studied the action of the pancreas in diabetes and worked also on the nervous system, and of Paul Bert, his pupil, who organized the teaching of natural sciences in France; of Duchenne, the originator of electrotherapy; of Broca, Charcot, Achard, Dastre, Carrel and others. The work of Pasteur was dealt with in a previous lecture. In concluding, the lecturer referred to the cordial exchange between British and French science which had been maintained for three centuries, save for the interruption of the Napoleonic wars, and said that whenever French scientists had been persecuted by religious bigots they had always found a refuge in England.—*British Medical Journal.*

SCIENTIFIC BOOKS

Medical Contributions to the Study of Evolution. By J. G. ADAMI. New York, The Macmillan Co. 1918.

Professor Adami has brought together in this volume his Croonian Lectures delivered in 1917 and a number of more or less cognate articles and addresses written or delivered at various times from 1892 onwards. The Croonian Lectures, entitled "Adaptation and Disease," form the *pièce de resistance* of the volume and present evidence drawn from bacteriological and medical sources, which, in the lecturer's opinion, indicate that variation in organisms is something "primarily acquired, proceeding from without," rather than something "primarily inherent, proceeding from within." The evidence submitted consists (1) of the effect of changed environment in producing structural or, more especially, physiological modifications in unicellular organisms, such as bacteria and (2) the effects of immunization in producing physiological modifications of organisms, shown by their increased powers of resistence. In both these classes of cases definite conditions primarily external produce definite modifications and these may therefore be regarded as acquired.

In collating data on the origin of variation from sources that are not always familiar to those whose studies lie in other fields Professor Adami has done good service, but unfortunately he combines with this a vigorous criticism of biologists in general for having failed to recognize the direct action of toxic substances on the germ cells or that of the environment on unicellular organisms. Far from being "shocked" at the suggestion of such ideas biologists have all along accepted them, even Weismann, who seems to be regarded as the *fons et origo* of "academic" biology; indeed, Professor Adami in an address of 1892, reprinted in the present volume, cites from Weismann a statement as to the effect of the environment on protozoa, which might well have been repeated in the lectures. Nor should the implication that zoologists have established a conspiracy of silence regarding Professor Gaskell's theories as to the origin of vertebrates be allowed to pass undisputed. Dr. Adami has apparently forgotten that a symposium upon these theories was held as one of the regular meetings of the Linnean Society, Professor Gaskell's work being thus accorded a recognition and an honor granted but rarely. Zoologists have been by no means unappreciative of the merits of Gaskell's observations even though they may have declined, for reasons that seemed to them sufficient, to accept his theories, and the insinuation that they acted the part of the Levite because Gaskell was a physiologist intruding in their territory is as unjust as it is incorrect.

A chapter on the significance of immunization as an example of a direct adaptation contains much that is of interest to biologists in general and this is followed by a chapter

on the inheritance of acquired conditions in the higher animals in which it is claimed that, notwithstanding Weismann to the contrary, there is distinct evidence of the inheritance of such conditions. This evidence is found in Stockard's experiments of breeding from alcoholized guinea-pigs. Here we are confronted by the resurrection of a time-worn discussion, which had its origin, to a large extent, in a failure to understand the meaning attached by Weismann and biologists in general to the terms "congenital" and "acquired." A congenital variation is for them one directly due to a modification of the constitution of the germ cell, while one that was acquired had its origin independently of the germ cell and could be supposed to affect it only secondarily and indefinitely, if at all. Stockard's cases are manifestly examples of a direct intoxication of the germ cells, whereby these were impaired, the impairment being passed on through successive generations, just as changes due to the environment may be transmitted through several generations of bacteria. These cases do not therefore bear on the question of the inheritance of acquired variations, using that expression in the Weismannian sense, but they do show most admirably the cumulative effects resulting from the conjugation in successive generations of vitiated germ cells.

Dr. Adami does not, however, direct all his energies towards the discomfiture of biologists. In the concluding chapters of the lectures he assumes a constructive rôle and outlines a theory of variation and differentiation which is worthy of serious consideration. It assumes as the structural units of the cell the complex protein molecules, each with numerous lightly linked side-chains and capable, therefore, of ready modification under changed conditions. The details of the theory can not be discussed here and those interested must be referred to the lectures and other contributions in which Professor Adami elaborates them, considering in a suggestive manner the phenomena of enzyme and hormone action and of immunity in the light of this chemico-physical hypothesis. The theory can not yet be taken as more than a suggestion, but if it can serve to diagrammatize for us other complicated phenomena as clearly as it has those of fertilization at the hands of Lillie it will become a useful working hypothesis.

The second part of the book consists for the most part of earlier articles and addresses containing the substance of the ideas that have been worked up into the Croonian Lectures, but to these some additional chapters are added, one for instance on the myelins and potential fluid crystalline bodies of the organism, another on the dominance of the nucleus (both reprints of lectures delivered twelve years ago) and another on adaptation and inflammation. The third and concluding section of the volume is entitled "Growth and Overgrowth" and is a collection of addresses and articles dealing with the causation, characteristics and classification of tumors.

J. P. McM.

SPECIAL ARTICLES

STYLONICHIA IMPALED UPON A FUNGAL FILAMENT

The following observations of the curious result of the overzealous feeding activities of a protozoon were made during July, 1918, while the writer was giving the summer session courses in zoology at the State University of New Jersey and Rutgers Scientific School. The material which furnished the organisms here described was obtained from the spray filter bed of a sewage disposal plant near Dunellen, New Jersey. The particular sample of this material in which the organisms were observed had stood over night in a test-tube and, for examination, a small amount was transferred with a pipette from the surface of the fluid in the test-tube to an ordinary microscopic slide. At the first glance through the microscope the material was seen to be swarming with *Stylonichia*, propably *S. vorax* Stokes. Upon moving the slide about, a mass of zoogloeal material was observed and from it some slender branching filaments were projecting into the surrounding fluid.

It was upon these branching filaments that the writer was astonished to see numerous struggling *Stylonichia* impaled, with the filaments passing through their bodies. Not the least astonishing was the fact that many of the animals were located at points basal to branches of the filaments, indicating that they had been held prisoner for some time.

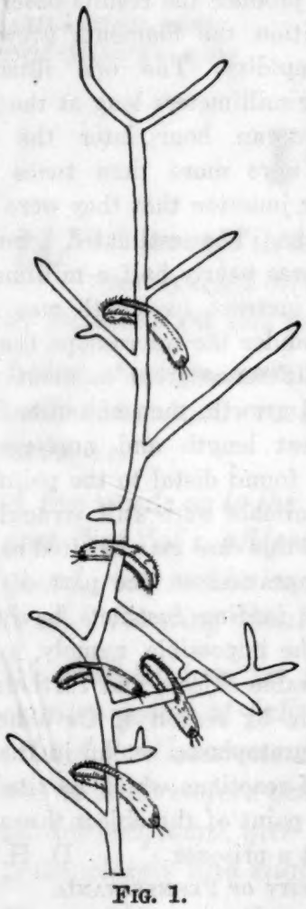

FIG. 1.

The accompanying sketch (Fig. 1), drawn free hand at the time, indicates fairly accurately the conditions on one filament. A number of other filaments were observed to be similarly decorated. From the illustration it will be seen that, beyond the protozoon most proximally placed on the filament, nine branches had arisen and beyond the most distal of the ciliates two branches had formed. Further, it will be observed that the animals invariably had their oral, or ventral, surfaces turned toward the base of the filament and that the filament passed through the oral aperture, or cytostome.

Two ideas are suggested by these conditions; first, that the *Stylonichia* may have become impaled as a result of efforts to swallow the tip of the growing filament, and second that the growth of the filament was comparatively rapid. Subsequent observations confirmed these impressions.

During the two hours following the discovery of the impaled animals some eight or ten individuals were seen to make the attempt to swallow the tip of one or another of the branches of the filaments. *Stylonichia* are known to be energetic feeders and, according to Stokes, this particular species is especially voracious, hence its specific name, *vorax*. In the observed instances the tip of a filament would be taken in until its extremity was near the posterior end of the animal. After a short time spent in the hopeless effort to devour the filament the ciliate would make an attempt to back away and divest itself of the unaccommodating object. In every case of this kind it appeared that the tip of the filament adhered somewhat to the protoplasm of the protozoon, thus interfering greatly with its effort to release itself. There ensued therefore a struggle upon the part of *Stylonichia* which, while possibly not describable as "frantic," nevertheless gave evidence of taxing the powers of the animal to the utmost; and it gave rise to reactions which were decidedly opposed to the success of the object to be attained. To adopt anthropomorphic phraseology one might say that the animal, becoming desperate, seized upon anything at hand in an effort to pull itself away from the now offending "thorn in its flesh." The most convenient and in fact usually the sole object offering such a possible means of escape was the filament itself. Consequently the animal clung to the filament with its strong ventral cirri and endeavored in this way to pull itself away from the tip. The result was to pull itself still further on to the filament and thus to cause the tip to be thrust further into the protoplasm and even—as shown by

the impaled individuals—through the cortex to the outside.

While no animals were observed actually to thrust the filament through their bodies in this way, in several cases they were seen to be pulling with force sufficient to cause a distinct papilla-like elevation on the outer surface and it was easy to see how a slightly stronger pull would have caused the tip to penetrate the cortex, thus impaling the struggling creatures.

In every case of attempted ingestion observed, however, the animals sooner or later abandoned the effort to escape by "climbing" the filament itself; then by turning one way and another, even whirling about the tip at times, they were able eventually to disengage themselves. Had they pulled on the filament while the tip was in the region of the thin cortex at the contractile vacuole, it is probable that penetration would have taken place more readily.

By their efforts to free themselves after becoming impaled the ciliates frequently produced great holes through their bodies much larger than the diameter of the filament. It seemed therefore that they might possibly have escaped by enlarging these holes through constant pushing and pulling until a rupture was produced at one side. None of them were observed to escape in this way although in some only a relatively narrow strip of cortex prevented.

One instance was noted, when the observations began, in which an individual was impaled with its aboral or dorsal side toward the base of the filament. It was near the end of a branch and by pulling on the part of the branch distal to it the animal was soon enabled to reach the end and escape. This exception to the rule can best be accounted for by supposing that the individual was accidentally stabbed through during the transfer to the slide with the pipette. In all the other cases observed, as noted above, the oral sides of the animals were toward the base of the filament.

As to the filament, its fungoid nature was indicated by the entire absence of color. It appeared to be far more rigid than most of the zoogloeal specimens and in fact its rigidity is attested by its effect on the protoplasm of its would-be devourer. The growing tips are seen to be rounded but tapering somewhat at the ends. The tapering and relatively rigid point would possess the necessary piercing powers to produce the results observed.

In addition the filaments grew with surprising rapidity. The one illustrated was about four millimeters long at the time it was drawn but an hour later the two distal branches were more than twice the length from their junction that they were at the time of drawing. The estimated growth during the hour was nearly half a millimeter and, in fact, the increase in length was so rapid as observed under the microscope that one could see the difference from moment to moment. The rapid growth, then accounts for the relatively great length and numerous branches that were found distal to the points where the pierced animals were still struggling.

Perhaps this case may be cited as an example of maladaptation on the part of *Stylonichia vorax*, its feeding instincts having led it to attempt the impossible, namely, to swallow an unswallowable object; and furthermore an object which, by reason of its adhering to the animal's protoplasm, set up in the struggle to free itself reactions which resulted in forcing the rigid point of the object through its body, making it a prisoner.

D. H. Wenrich
University of Pennsylvania

SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.
NEW YORK, N. Y.

Entered in the post-office at Lancaster, Pa., as second class matter